

CLAIMS

1. A control valve arrangement for use in controlling fuel pressure within a control chamber (30), the control valve arrangement including a control valve member (32) which is movable between a first position in which the control chamber (30) communicates with a source of high pressure fuel, and a second position in which the control chamber (30) communicates with a low pressure fuel drain and communication between the control chamber (30) and the source of high pressure fuel is broken, and restricted flow means (55;70; 86) for restricting the rate of flow of fuel from the control chamber (30) to the low pressure fuel drain when the control valve member (32) is moved from the first position to the second position
2. A control valve arrangement as claimed in Claim 1, wherein the restricted flow means is further operable for restricting the rate of fuel flow from the high pressure fuel source to the low pressure drain when the control valve member (32) is being moved between the second position and the first position, thereby to reduce the loss of high pressure fuel to low pressure.
3. A control valve arrangement as claimed in Claim 1 or Claim 2, wherein the restricted flow means is arranged so that fuel flow rate out of the control chamber (30) to the low pressure drain is relatively low whereas the fuel flow rate into the control chamber (30) is relatively high, thereby providing asymmetric control valve operation.

4. A control valve arrangement as claimed in any one of Claims 1 to 3, wherein the control valve member (32) is engageable with a first seating (38) when in the first position and with a second seating (44) when in the second position, wherein the first seating (38) is defined by a surface of a bore (34) provided in a valve housing (36) within which the control valve member (32) is movable.
5. A control valve arrangement as claimed in any one of Claims 1 to 3, wherein the control valve member (32) is engageable with a first seating (38) when in the first position and with a second seating (44) when in the second position, wherein the control valve member (32) is movable within a bore (34) provided in a valve housing (36) and wherein an insert (60) is arranged within the bore (34) in the valve housing (36), the insert defining the first seating (38).
6. A control valve arrangement as claimed in Claim 4 or Claim 5, wherein the second seating (44) is defined by surface of the bore (34) provided in the valve housing (36).
7. A control valve arrangement as claimed in any one of Claims 4 to 6, wherein the restricted flow means comprise a restricted flow passage (55) defined by an outer surface of the control valve member (32) and the bore (34) in the valve housing (36).
8. A control valve arrangement as claimed in Claim 7, wherein the control valve member (32) is shaped such that the restricted flow passage (55) is defined, in part, by a control flat provided on the outer surface of the control valve member (32).
9. A control valve arrangement as claimed in Claim 7 or Claim 8, wherein the

restricted flow passage (55) is located in between the first seating (38) and the second seating (44).

10. A control valve arrangement as claimed in any of Claims 4 to 9, wherein the restricted flow means is arranged upstream of the first seating (38) and downstream of the second seating (44).

11. A control valve arrangement as claimed in any of Claims 4 to 9, wherein the restricted flow means is arranged downstream of the first seating (38), between the first seating (38) and the low pressure drain.

12. A control valve arrangement as claimed in any of Claims 1 to 11, wherein the restricted flow means is defined by an orifice (70) provided in the control valve member (32).

13. A control valve arrangement as claimed in any of Claims 1 to 12, wherein the control valve arrangement includes a by pass flow means (80, 86) arranged within the control chamber (30).

14. A control valve arrangement as claimed in Claim 13, wherein the by pass flow means includes a plate valve arrangement including a plate valve member (80) provided with a control orifice (86) extending therethrough.

15. A control valve arrangement as claimed in Claim 14, wherein a wall of the control chamber defines a plate valve seating (90), whereby the plate valve member (80) is moveable against the plate valve seating (90) by means of fuel pressure

within the control chamber (30), so as to ensure the flow of fuel from the control chamber (30) passes through the control orifice (86) when the plate valve member (80) is engaged with the plate valve seating (90).

16. A control valve arrangement as claimed in Claim 15, wherein the control chamber (30) is shaped to define a by pass flow passage around the plate valve member, whereby a substantially unrestricted flow of fuel can enter the control chamber (30) when the plate valve member (80) is urged away from the plate valve seating (90).

17. A fuel injector for use in delivering fuel to an internal combustion engine, the fuel injector comprising a valve needle which is engageable with a valve needle seating, in use, to control fuel delivery through an outlet opening, a surface associated with the valve needle being exposed to fuel pressure within a control chamber, a control valve arrangement for controlling fuel pressure within the control chamber (30) so as to control fuel injection and operable in response to fuel pressure within the control chamber (30) so as to permit a restricted fuel flow rate out of the control chamber (30) during valve needle lift and an increased fuel flow rate into the control chamber (30) during pressurisation of the control chamber (30) to terminate injection.

18. A fuel injector for use in delivering fuel to an internal combustion engine comprising a valve needle which is engageable with a valve needle seating, in use, to control fuel delivery through an outlet opening, a surface associated with the valve needle being exposed to fuel pressure within a control chamber (30), and a control valve arrangement as claimed in any of Claims 1 to 17 for controlling fuel pressure

within the control chamber (30).

19. A fuel injection system for an internal combustion engine comprising a fuel injector as claimed in Claim 17 or Claim 18.